

## Continued Success with Biological Control Agents of Squarrose Knapweed

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Squarrose knapweed, *Centaurea squarrosa*, the most widely distributed knapweed in California, was not targeted for biological control until 1995. The far greater prevalence and distribution of spotted and diffuse knapweeds in North America focused selection of potential natural enemies to these weeds. Host specificity testing prior to introduction suggested that several of these insects could attack more than one species of knapweed so we began releasing biological control agents on squarrose knapweed that had been selected for, established on, and collected from spotted and diffuse knapweed. Following a brief project in Siskiyou County in 1996, we began a larger, monitored project in the Pittville area of Lassen County in 1998. Two species of seedhead weevils, *Bangasternus fausti* (Reitter) (Coleoptera: Curculionidae), and *Larinus minutus* Gyllenhal (Coleoptera: Curculionidae), established rapidly increasing to extremely high levels so that well over 95% of the squarrose seed was destroyed on squarrose plants around the Pittville release site. This early success encouraged us to expand bioagent distribution and monitoring to additional sites to confirm establishment success and impact.

Bioagent population development and impact on squarrose knapweed seed production are shown in Figures 1a and 1b. Site A is the original Pittville release site for *Larinus minutus*. The weevil *B. faustii* was released about 50 meters south of this site. The total infestation rate (either weevil), increased very quickly and has remained over 95% for five years (1999 through 2003). While non-attacked seedheads usually contain one to two seeds per head (mean = 1.44 seed/head), the high infestation rate has reduced mean seed production to less than 0.05 seeds per head, a decrease of 99% (Figure 1b years 2000 through 2003). Site B is several hundred meters east of site A and no insects were intentionally released at this site. The two year delay in bioagent establishment and ultimate seed reduction at site B reflects the time needed for natural dispersal of the biological control insects from site A. Following the delay, however, the 95% attack rate and 99% seed reduction applies. Site C is located several miles distant from sites A and B and did not have insects prior to a large release in 2001. The weevils established readily at site C, however, essentially eliminating seed production at this site in two years. Site D is located about 200 meters north of site C and seems to be confirming the Site B results. Weevil migration from site C to site D has already occurred and the site is perhaps one year behind results from site C. The dramatic results at these sites are being followed by additional monitoring at these sites as well as at new sites infested with squarrose knapweed.

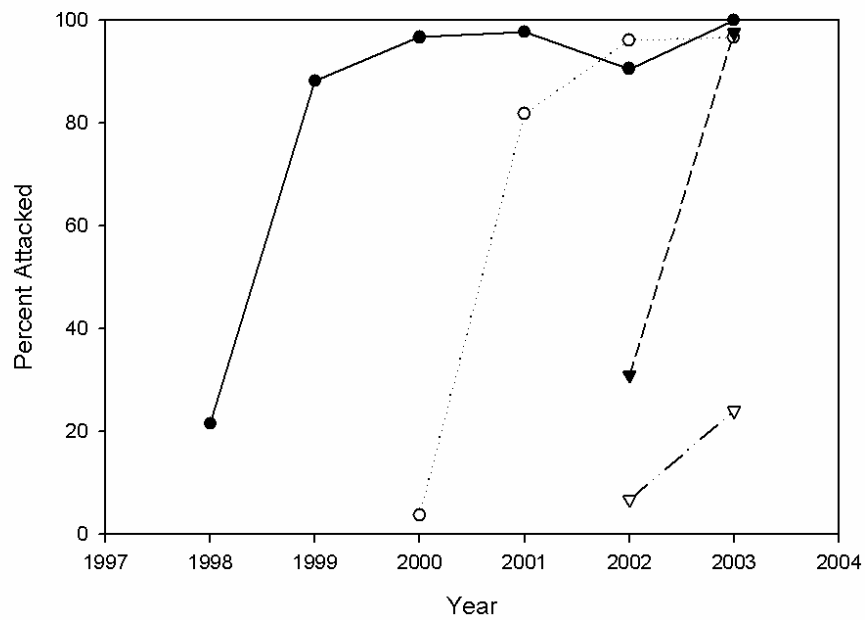


Figure 1a. Seedhead attack of squarrose knapweed

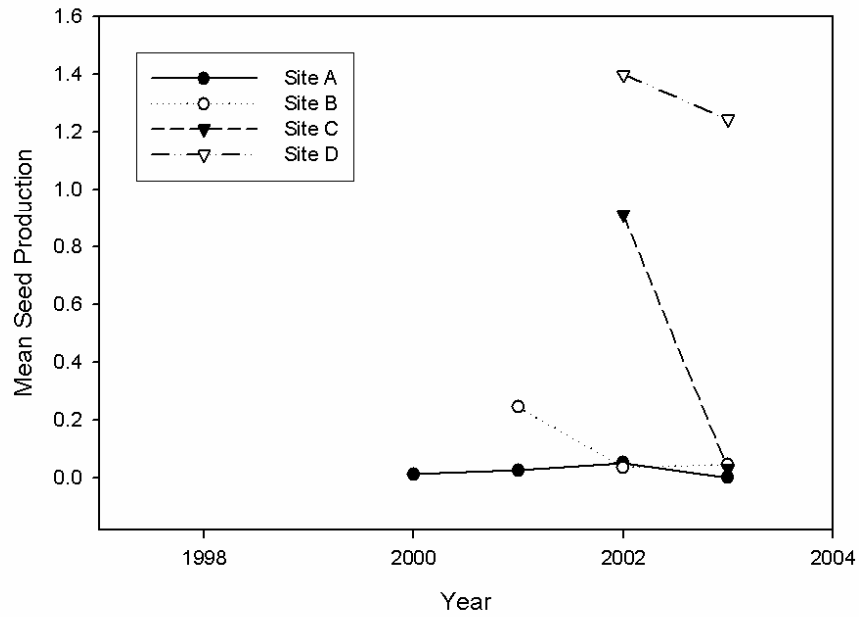


Figure 1b. Seed production of squarrose knapweed